

Notes on wine growing and the Circular Economy in the context of intensifying climate change

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Abstract

This article addresses the Circular Economy within the scope of wine growing from an interdisciplinary perspective. Conceiving wine as a cultural, social, and economic item resulting from progressively elaborate techniques, the text highlights the transformation of wine into a product of big business. Wine's dependence on environmental factors, and association with various negative environmental impacts, particularly the increasing production of waste are discussed. The article presents how the need to control these impacts is growing in various contexts, mainly because of the intensification of climate change. It also examines how the notion of circular economy has become a guiding axis for the reconfiguration of this field, both in terms of mitigating its impacts and exploring other potentials related to wine production. Focusing on the Brazilian context, it presents the peculiarities of local grape and wine production and the advancement of research based on the management of solid waste. In parallel, it points to obstacles that arise in the implementation of greater circularity in this field.

Keywords: Wine, Viticulture, wine production, Circular Economy, Solid waste, Climate change.

Notas sobre vitivinicultura e Economia Circular no contexto de acirramento das mudanças climáticas

Resumo

Este artigo aborda Economia Circular no âmbito da vitivinicultura a partir de uma perspectiva interdisciplinar. Concebendo vinho como item cultural, social e econômico, resultante de técnicas progressivamente elaboradas, ressalta sua transformação em produto da grande indústria. Aponta sua dependência dos fatores ambientais, ao mesmo tempo, sua associação a diversos impactos ambientais negativos, destacando-se a produção crescente de resíduos. Aponta como a necessidade de se contornar essa problemática vem crescendo em diversos contextos, fundada sobretudo no acirramento das mudanças climáticas, e como a noção de Economia Circular tem se constituído eixo norteador para a reconfiguração desse campo, tanto no sentido de se dirimir os impactos referidos quanto em explorar outros potenciais relacionados à vitivinicultura. Enfocando o contexto brasileiro, apresenta particularidades da vitivinicultura local e o avanço de pesquisas a partir da gestão dos resíduos sólidos. Paralelamente, aponta para os obstáculos que se apresentam no âmbito da efetivação de maior circularidade nesse campo.

Palavras-chave: Vinho, Vitivinicultura, Economia Circular, Resíduos sólidos, Mudanças climáticas.

Notes on wine growing and the Circular Economy in the context of intensifying climate change¹

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Introduction

Wine is above all the result of human action, and there is very little left in the production of this drink that can be considered *natural*, something untouched by human hands (Black, 2013). Wine is therefore a cultural product and, as such, is also the result of the progressive use of techniques, which have been increasingly improved. Over time, these techniques have allowed for greater control over the different stages of wine production, from soil preparation and growing and harvesting grapes, to fermentation, conservation, bottling and labeling. These processes made it possible for wine to withstand long-distance travel while retaining the flavor of its place of origin. Like many other foods offered for consumption in our contemporary world, from being a locally produced and consumed beverage, wine has also become a product of big business, developed at large scale, and distributed on an increasingly global scale. As a result of this process, the wine industry has had a growing environmental impact.

Although it is not a basic necessity and there is still a certain dichotomy regarding its consumption², wine is an agricultural product, and seen as food, considering it contains energy and nutrients. From this perspective, it also encompasses other dimensions. Black and Ulin (2013), who note that there are few studies of wine, affirm that categorizing wine only as an alcoholic beverage winds up obscuring its ritual, symbolic and social importance.

To this extent, wine can also be seen as a manifestation of the relationship of humans with their environment, although it is not always a harmonious relationship, revealing tensions between human beings and their natural environment (Black and Ulin, 2013). This perspective also applies to reflecting on its production and consumption, at a time when environmental problems are worsening, questioning the very continuity of winemaking as we know it.

Wine production depends on several factors, including the good interaction of land, water, and air. From this perspective, the environment in which a wine is produced is conceived as one of the fundamental aspects for its qualification and valorization, especially in terms of its cultural dimension. These factors are part of the notion of *terroir*³, which has contributed to the constitution of imaginaries related to this drink, contributing to

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² Grivetti (1995) argues that perhaps no other food shares with wine the dichotomy, which has been expressed since the past, of being praised when consumed in moderation, while condemned when consumed in excess.

³ The concept of *terroir* originated in France and its significance was initially focused on various French agricultural products, in addition to wine. However, in the early twentieth century, the concept became predominant in the wine sector, to the extent that in terms of *terroir*, wines were associated with specific properties and regions. This was especially important to laws for controlled appellation that emerged in the 1920s that sought to ensure the notion of a regional product (Ulin, 2013), among other objectives. This perspective also extends to the growing appreciation of processes that highlight the origin of products, materialized in the form of certification systems, such as the Denomination of Origin (DO) and the Indication of Provenance (IP). The concept also serves to exalt certain wines. In the words of Patterson and Buechsenstein (2018), for example, the notion of *terroir* is at the heart of what makes a wine special.

the prestige of various areas around the world⁴. But while it is dependent on the environment, wine production generates negative environmental impacts, including the production of waste.

The intensification of solid waste production is a global problem. Industrialized societies marked by intensive consumption are responsible for the greatest generation of waste. According to the United Nations (UN), more than 2 billion tons of waste are produced worldwide every year⁵. In the face of the growing environmental crisis, marked by the acceleration of climate change, the production and management of waste has become a crucial issue. In the field of grape and wine production, environmental issues have taken center stage in recent years. The frequency and intensity of extreme weather events has jeopardized the continuity of wine production in various regions, while provoking the need for a reordering in this field.

Using an interdisciplinary perspective, we examine the main negative environmental impacts of vineyards and wineries, considering the worsening climate crisis. We then focus on the notion of circular economy as a guiding principle for reconfiguring this field, both in terms of reducing these impacts and exploring other potentials related to wine growing. Finally, we look at the Brazilian context, the particularities of local vineyards and wineries, and the progress of research into solid waste management. We also point out obstacles to achieving greater circularity in this field in the country.

Environmental impacts of vineyards and wineries and the climate emergency

Wine has been produced since ancient times. Over time, its production has expanded worldwide⁶, in keeping with globalization processes. Meanwhile, wine has been incorporated even in countries where its consumption was previously non-existent. Progressive technological improvements involving production, distribution and marketing have favored industrial production of wine, contributing to its transformation into a progressively globalized product.

More than 67 countries now produce, export, import and consume wine (Zacharof, 2017). The expansion of winemaking has also led to its alignment with changes that have taken place in agricultural practices in many countries since the middle of the last century, a period when techniques were developed to boost food production and transcend scarcity. As a result, the agri-food system became increasingly conditioned to the use of agrochemicals, a fact explored in the renowned book by biologist Raquel Carson, *Silent Spring* (2010 [1962]), in which she denounced risks related to the indiscriminate use of pesticides in the United States after World War II. As Shiva (2016) explains, this post-war period experienced what became known as the Green Revolution, which placed new demands on scarce renewable and non-renewable resources and required heavy investments in fertilizers, pesticides, seeds, water, and energy⁷. In this context, intensive agriculture generated severe ecological destruction, marked by the waste and destruction of land, water sources and biodiversity, causing new types of scarcity and vulnerability, as well as new levels of inefficiency in the use of resources.

It can therefore be considered that, from a broader perspective, the development and expansion of wine growing over the last century has reflected the panorama of changes in agri-food systems on a global scale brought about by food modernization. A model based on intensive production thus prevails, in which the

4 On representations linked to the notion of *terroir*, from a social, cultural, historical, and political perspective, see Daynes (2013) and Ulin (2013).

5 Available at: <https://nacoesunidas.org/humanidade-produz-mais-de-2-bilhoes-de-toneladas-de-lixo-por-ano-diz-onu-em-dia-mundial/> Accessed on: Sept. 10, 2022

6 About the global expansion of grape and wine production see: Phillips (2005); McGovern & Fleming (1994); Johnson (1999); Tattersall & Desalle (2015).

7 Data from 2018 from the now-defunct Brazilian Wine Institute (Ibravin) on the registration of pesticides in Brazil for growing vines revealed that of the 61 herbicides registered, 14 are extremely toxic; of the 49 insecticides registered, 14 are extremely toxic and of the 159 fungicides registered, 58 are extremely toxic. Many of the pesticides widely used in Brazil have been banned in several countries. Research carried out by Bombardi (2017) revealed that, of the pesticides used on grapevines in Brazil in 2019, 13 had been banned in the European Union. According to data published by the Brazilian Ministry of Agriculture, 474 new pesticides were registered in the country in 2019 alone, more than in the previous 14 years combined. In 2021, this number rose to 562, helping to maintain Brazil's position as world champion in the use of pesticides in agriculture.

search for quality and competitiveness in wine production reflects a dynamic in which foods are mass-produced at a lower cost and can therefore circulate widely around the world. Like the production of many other food items, wine production involves massive generation of waste and a growing use of chemical inputs, such as synthetic fertilizers, pesticides, herbicides and acaricides. Therefore, while in the past vineyards and wineries also involved modifying landscapes and altering ecosystems, the negative socio-environmental impacts of this activity have become progressively worse⁸.

As Christ and Burritt (2013) point out, the negative environmental consequences of winemaking are mainly related to water consumption, impacts on water quality, the generation of solid organic and inorganic waste, the use of large amounts of energy, considerable greenhouse gas emissions, the use of chemicals (pesticides, fertilizers and other chemical products), and land use problems⁹. According to these authors, these issues can be further categorized according to the stage of the supply chain in which they occur: viticulture, winemaking, or distribution. In addition to these impacts, one can also include the manufacture and disposal of bottles, corks - which involve the cultivation of oak - and labels, the refrigeration of wines, and the transportation of wines to retailers. The distribution and post-production logistics of this drink are also intensive in terms of carbon dioxide (CO₂) emissions, partly due to the dependence on heavy and bulky forms of packaging - among others.

It is now commonly recognized that the intensification of environmental degradation is directly linked to the acceleration of climate change, which is reflected in increased flooding, storms, forest fires, droughts, species extinction and ocean acidification, among other consequences. According to the latest report from the Intergovernmental Panel on Climate Change (IPCC), released in 2022, there is no doubt that human activities are responsible for global warming¹⁰. The impacts of human action on the planet are marking a new geological epoch, known as the Anthropocene. Based on this concept, a new moment in the history of the earth has begun in which humanity has become the most powerful influence on global ecology (McNeil; Engelke, 2016).

Among the main activities associated with the climate crisis are those linked to agriculture and food production, which account for about one-third of greenhouse gas emissions. Data for 2021 from the World Meteorological Organization (WMO) show that atmospheric levels of greenhouse gases have reached amounts¹¹. Between 1990 and 2021, the warming effect derived from these long-lasting gases increased by almost 50%, with carbon dioxide being responsible for around 80% of this increase¹². In Brazil, 2021 was marked by the highest rate of greenhouse gas emissions in the last 19 years¹³. In October 2019, scientists from the Intergovernmental Panel on Climate Change (IPCC) issued a warning about the importance of halving greenhouse gas (GHG) emissions by 2030 and bringing them to zero by the middle of the century, to avoid the even more intense impacts of climate change.

8 Since the 1990s, in the context of advanced globalization, the number of wine-producing countries considered in the quality category (wines produced from *vitis viniferas*), which was previously limited and concentrated on the European continent, has changed significantly. Countries recognized for their wine production in the past, such as France, Italy, and Spain, have had to face international competition for wines, especially from countries such as Chile, Australia, the USA, and South Africa.

9 As Christ and Burritt (2013) argue, the cultivation of wine grapes and wine production are not environmentally benign activities. The fact that viticulture has been established in certain regions for a long time and that the vines are grown in a permanent culture, results in long-term problems such as soil compaction, water pollution, and destruction of fauna and flora, contributing to environmental degradation (Rosner et al., 2015).

10 According to the IPCC, of the 1.1°C of warming that has occurred since the pre-industrial era, less than 0.1°C is related to natural forces such as volcanoes or variations in the sun.

11 Data from SEEG, the Climate Observatory's System for Estimating Greenhouse Gas Emissions, revealed that in 2021, Brazil's greenhouse gas emissions had their highest increase in almost two decades, reaching 2.42 billion gross tons of CO₂, an increase of 12.2% over 2020 (2.16 billion tons). Also according to the SEEG, the last decade saw the biggest growth in emissions in human history: 9.1 billion tons more than in the previous decade - even with the growing publicity about environmental problems.

12 The goal is to achieve what was stipulated in the Paris Agreement, limiting global warming to below 2°C, preferably 1.5°C, above pre-industrial levels. WMO data indicates that the average global temperature is now more than 1.1°C above the pre-industrial level of the 1850-1900 period.

13 Available at: <https://news.un.org/pt/story/2022/10/1804397> Accessed Nov. 2/2022.

With regard to the influence of wine production on the worsening climate crisis, since 2018, the International Organization of Vine and Wine (OIV), the main body promoting grape and wine production at a global level and of which Brazil is a signatory, has included in its recommendations to the various national bodies that are members of this institution the need to implement more sustainable practices at vineyards and wineries. This guideline also considers the impacts on wine growing caused by climate change, which is affecting both small and large wine producers in different countries, including Brazil.

In some wine-growing regions the systematic increase in temperatures associated with global warming has contributed to the quality and quantity of grapes and has even hindered the emergence of fungi in vineyards. But more broadly, it is noted that extreme temperatures are causing major heat waves (according to experts, this is a factor that can cause fruit to dry out, impeding growth), frosts and hail, damaging harvests in different seasons. For example, in 2021 Brazil's main wine-growing region, the Serra Gaúcha, suffered from intense frosts that compromised the development of shoots of some wine varieties.

In addition, recurrent forest fires have been decimating vineyards and turning renowned wineries into ashes. Observing the increased frequency of these events and the fact that wine grapes are very sensitive to changes in climate and temperature, the climate crisis is putting the survival of grape and wine production at risk in Brazil and various regions around the world¹⁴.

A 2017 report on the state of world wine production by the International Organization of Vine and Wine (OIV)¹⁵ pointed to an 8.2% drop in world wine production, representing one of the lowest levels in several decades, due to extreme weather events, ranging from frost to drought in Europe's leading producers, Italy, France, and Spain, as well as Germany¹⁶. As global climate change intensifies, extreme events, such as prolonged drought, are expected to become even more common. (Herberger, 2012)¹⁷.

In the past, to make a wine considered to have good quality, the focus was on the variety of grape to be grown, the cultivation and harvesting methods and control of the fermentation process. In the face of the unpredictable conditions imposed by the environmental crisis, uncertainties are emerging about the precision of these stages.

Brazil ranks 14th in world wine production. In addition to the negative environmental impacts of grape and wine production mentioned, which are also found in this country, most wine production, in addition to generating a large amount of waste, is guided by an agricultural model based heavily on monoculture and the use of synthetic agrochemicals, causing damage to the environment and to human and animal health. Instead of reviewing this production model, the search for a standard of excellence for Brazilian wines to allow them to compete in the international market has prioritized the development of cutting-edge technologies to control all stages of production and increase productivity.

14 Similar to what happened in Napa Valley, California, on the west coast of the United States, between 2020 and 2021, devastating fires have also hit wine-growing regions in the south of France and Australia. In addition to destroying some wineries, the damage caused by these fires also includes changes in the taste of wine, due to the intensity of the smoke, and long-term effects, such as changes to soil caused by burning. In South America, Latin America's largest wine producer, the land area of Argentina's vineyards has been declining since 2015, reaching 211 kha in 2021. This is a reduction of 3.7 kha, or -1.7% from 2020. The reduction in Argentina's vineyards can be explained by the climatic factors facing its main wine-growing regions, mainly Mendoza, including water shortages, rising temperatures and drought-like conditions. In Chile, on the other hand, the land area of vineyards increased by 1% in 2021 compared to 2020, reaching 210 kha in 2021. After eight straight years of continuous decline, Brazil also increased the land area dedicated to vineyards in 2021, but only marginally, by 0.2%, reaching 81 kha in 2021.

15 Available at: <http://www.oiv.int/en/oiv-life/oiv-2018-report-on-the-world-vitivinicultural-situation> Accessed December 2022.

16 On changes in wine production related to the low levels of grape harvest due to unstable global climatic conditions, see: <http://www.fao.org/3/al176e/al176e.pdf> Accessed December 2022.

17 Particularly considering the global warming that has taken place over the last four years, which has caused a range of events, from cyclones to floods and extreme heat, experts are warning of the urgency of tackling climate change, as it is advancing faster than efforts to curb it. An example of this is the extreme heat that afflicted Europe in June 2019, with the highest temperatures ever recorded on the continent, averaging 2°C above normal. According to the World Meteorological Organization (WMO), this is a global trend that tends to become more intense, longer, and more frequent due to the increase in global temperatures caused by greenhouse gas concentrations, the consequences of which involve environmental and human health impacts. Available at: <https://news.un.org/pt/story/2019/07/1678802> Accessed December 2022.

Environmental issues are reshaping the geography of wine, since producers have been looking for growing regions that are less vulnerable to sudden temperature changes¹⁸. Moreover, in Brazil and other countries much research has focused on developing grape varieties that are more adaptable/resistant to climate change. This includes genetic improvements to wine varieties to make them more resistant to fungi and, consequently, do not require intensive use of agrochemicals. This research may be a step forward, but it doesn't solve all the environmental problems associated with this activity.

It's not hard to see that events related to the climate crisis are progressing very quickly and in almost always unpredictable ways. One example is the recent extreme heat in Europe, where much of the world's wine production is still concentrated¹⁹. According to the European Climate Change Service, October 2022 had the hottest temperatures ever recorded on the continent for the month, with temperatures almost 2°C above the average of the period from 1991 to 2020²⁰.

While the climate crisis has recently had a strong impact on vineyards, it can be affirmed that grapevines have displayed tremendous resilience over their seven millennia of existence. Over the last few centuries in particular, viticulture has faced more intense adversity. The case of phylloxera, which decimated vines in Europe in the 19th century, is still a reference in this sense. Problems such as mildew and oidium, among other fungi, persist as threats to be combated in various regions of the world, including Brazil. And climate change have already left important marks on viticulture as we know it today. Since the period known as the "Little Ice Age" (1300-1850), changes have led to modifications in wine production and trade. Due to temperature decline, viticulture retreated from northern European regions. While sweet wines were developed in the Mediterranean region, in the new frontier areas, such as Champagne, there was a shift from red to white wine production (Campbell; Guibert, 2007).

Although this may suggest the resilience of viticulture to extreme events, the fact is that as the changes related to the emerging climate crisis highlight the unsustainability of the current production model²¹, they also point to the need for a broader re-dimensioning, which includes the implementation of greater circularity in this field.

Grape and Wine Production, Generation of waste and a Circular Economy

Since ancient times, wine has played a significant social, cultural and economic role²². In recent years, in addition to the increase in worldwide demand for this beverage²³, its production has contributed to a growing number of national economies, including those of several emerging countries, which also means that it generates work and income for many individuals and even families. But as the industry expands, so do its negative socio-environmental impacts. As mentioned, the large volume of waste has been identified as

18 In Bordeaux, France, some winemakers have been using less merlot in their blends, and in Napa Valley, California, there has been a decrease in the use of cabernet sauvignon grapes due to rising temperatures. Available at: <https://gizmodo.uol.com.br/crise-climatica-regioes-vincolas-risco/> Accessed November 25, 22.

19 Available at: <https://news.un.org/pt/story/2019/07/1678802> Accessed 10/October/2022.

20 Available at: <https://www.dw.com/pt-br/europa-teve-neste-ano-o-outubro-mais-quente-já-registrado/a-63687953> Accessed November 15, 2022.

21 When thinking about sustainable agriculture, one can begin with the perspective of Sachs (Sachs, 1990, 2002), for whom sustainability must encompass various dimensions, ranging from the environmental to the social, economic, ecological, territorial, cultural, national political and international political. It is also important to note that in the sphere of agriculture, apart from the preservation of soil and water in particular, orientation towards a more sustainable approach involves minimal use of artificial inputs from outside the agricultural system, the restoration of environmental disturbances caused by cultivation and harvesting, and the establishment of a foundation as an economically and socially viable activity (Gomiero et al., 2011). In addition, the restoration of biodiversity in agricultural landscapes is also considered fundamental in the context of sustainable agriculture, since biodiversity, among other aspects, allows agro-ecosystems to improve both soil fertility and crop protection and productivity. (Altieri, 1999).

22 For a broader view, especially of the economic aspects linked to wine since the past, see: Unwin (1996).

23 For data on the growth of world wine consumption see: "State of the World Vine and Wine Sector 2021", OIV available at: <https://www.oiv.int/public/medias/8778/eng-state-of-the-world-vine-and-wine-sector-april-2022-v6.pdf> Accessed on 20/10/22.

a problem that must be overcome in various contexts. For this reason, the concept of the Circular Economy has become a guiding principle for the reconfiguration of wine production, both in terms of eliminating the impacts mentioned and exploring other related potentials.

Based on the principles of reducing, reusing, refurbishing and recycling materials and energy (the so-called 4 Rs), the Circular Economy is a proposal focused on reconfiguring the current linear economy that is based on the extraction, production and disposal of *natural resources*. The objective is to develop a more circular economic model based on an increased use of renewable energy sources and the continuous reuse of materials/waste, so that they can be kept within the production cycle as long as possible²⁴. In this perspective, “waste” is conceived as a “food” that serves as a basic element in regenerative production cycles to generate more positive environmental and social impacts (McDonough, 2002)²⁵.

As Weetman (2021) affirms, the impacts of systematic environmental degradation related to the logic of the linear economy (take, make, waste) have led us to “ecological excess”²⁶. Today’s economy depends not only on water and land, but also on metals, minerals and fossil fuels, elements that are finite and are wasted when a product is discarded. In addition, it must be recognized that this means that labor and knowledge invested at each stage of the production process are also wasted. The climate emergency, the global crisis, and the recent pandemic accompanied by the shortage and consequent increase in the prices of raw materials revealed the urgent need to seek an economy based on circularity in a wide variety of areas, including the field of wine production.

In recent years, greater focus by companies, institutions, and consumers on the growing environmental problems in the wine industry has led to a proliferation of projects, protocols, and tools to promote greater circularity and sustainability (Christ and Burrit, 2013). Among these strategies is the development of solutions for managing wine production waste.

Wine production generates solid and liquid waste. Solid waste comes from the grape harvest (grape stalks, grape pomace and seeds, leftover packaging, and other sources)²⁷. Liquid residues are produced during winemaking (Zacharof, 2017). Their mismanagement, through improper disposal, not only causes socio-environmental damage, but is a form of waste given the many possibilities related to its use.

The main solid waste derived from wine production is grape pomace, which consists of the pulp of the berries, skins, seeds, and stalks. In Brazil, research has been conducted to explore the potential for using this residue²⁸. This research has revealed various possibilities for greater circularity in the wine-growing field, since the by-products of wine making can be used in food, supplements, pharmaceuticals and cosmetics, animal feed, fertilizers, bio-inputs, solid and gaseous fuels, energy production, and other industries.

Some countries have advanced policies to implement sustainable practices in wine production, with the objective of creating a more circular economy. Among the world’s leading wine-producing countries, Italy is a case in point. Interviews conducted at wineries in Sicily, in southern Italy, showed that practices aimed at environmental preservation were being revived, based on the notion of a more “natural” viticulture, without the use of agrochemicals, “as in ancient times”.

24 See: <https://archive.ellenmacarthurfoundation.org/pt/economia-circular/conceito>

25 About the idea of garbage as food see: McDonough (2002) and Raworth (2017).

26 Weetman (2021) maintains that the world’s population consumes at the level of 1.75 planets each year and, in the past 50 years, we have caused the degradation of 60% of the Earth’s ecosystems.

27 Grape stalks are the main waste that comes from the grapevines.

28 Some examples of these studies can be found in: EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA - EMBRAPA. BASTOS, A. 2018. Bagaço de uva vira alimentos funcionais. 2018. Available at: <<https://www.embrapa.br/busca-de-noticias/-/noticia/2235712/bagaco-de-uva-vira-alimentos-funcionais>> Accessed Nov. 21, 2022. EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA - EMBRAPA. BASTOS, A. Cientistas desenvolvem produtos com resíduos da indústria vinícola. 19 jun 2018. Available at: <<https://www.embrapa.br/busca-de-noticias/-/noticia/34950363/cientistas-desenvolvem-produtos-com-residuos-da-industria-vinicola>> Accessed Nov. 21, 2022 and Tonon et al. (2018).

As far as waste management is concerned, the country's waste circularity rate is 18.5%, which places it in second place after the Netherlands among countries with advanced waste management policies. In the field of viticulture, Italy's main wine cooperative, which is the largest wine producer by volume in the country, covers 7 regions and includes 12,000 vineyards and wineries. The cooperative is a pioneer in the development of a Circular Economy in the sector and an example of how greater circularity can be achieved in this field, since the cooperative uses all the waste from wine production²⁹.

Observing the experience of other countries can also indicate how the production and management of wine-growing waste varies from one context to another. What is considered "garbage" or waste to be disposed of can acquire new meanings and different attributions, since the definition of "garbage" is also permeated by cultural aspects, not necessarily resulting from an objective condition of material culture, but above all from a subjective condition. According to Mary Douglas (1991), waste is not a fixed category of things, but something that results from classification and relationships. Much of what can be conceived as "garbage" or waste is not something that necessarily has no use value or has lost its use value, but rather something that has come to be defined as valueless, i.e. the conditions under which garbage is understood are also culturally determined (Thompson, 2017)³⁰.

But the way in which waste is conceived or used can also be linked to the development of policies in this field and, above all, their effective implementation. In 2010, Brazil approved a National Solid Waste Policy (PNRS), whose principles are anchored in circularity, that is, they include encouraging the adoption of sustainable production and consumption patterns³¹. Although it is considered one of world's most advanced legislation in this field and has led to some progress, its results are still considered insignificant in terms of reducing the improper disposal of waste and various obstacles to the implementation of municipal solid waste plans, the correction of sanitary landfills and the condition of waste pickers, among other factors (Dutra, 2021; Mattos, 2021).

Although Brazil is not among the world's top wine producers, the activity has been growing in recent years. The southern regions and the São Francisco Valley account for most of the country's production. Data from the International Organization of Wine and Vine (OIV) shows that in 2021 Brazil produced 3.6 million hectoliters of wine, the highest production since 2008 (+60%). Although not as significant as in other countries or as other agri-food crops grown in the country (sugar cane, coffee, oranges, among others), the figures indicate expansion of this activity. Consequently, they suggest an increase in related socio-environmental impacts and the need to seek more sustainable solutions in this field. As Porto-Gonçalves (2015) observes, the transformation of an ecosystem into an agro-ecosystem will always imply a loss of social and environmental impacts, that is, regardless of the extent of cultivation, agricultural activity will always have some negative impact.

According to the Brazilian Agricultural Research Corporation (Embrapa), the main destinations for grape pomace in Brazil are composting or animal feed (Tonon et al., 2018). Data from this institution shows that only 3% of the total amount of waste generated from wine production in the country is used (Tonon et al., 2018). This indicates that most of this waste in the country is discarded, also indicating that the absence of norms governing the correct management of this waste will inevitably lead to environmental pollution.

From this perspective, an example of the lack of a more circular approach to waste management can be seen in the mountain region of Santa Catarina where viticulture has been developing for some twenty years. Interviews conducted at wineries in this region at the end of 2022, specifically in the municipality of São

29 The waste is used for renewable energy, the lees are transformed into biogas for electricity and heat, the bagasse is also used to produce electricity, polyphenols are extracted from the grape seeds for oenological, food and nutraceutical use; and to produce the natural food coloring enocyanin and tartaric acid for oenological, food, pharmaceutical and construction use. The waste is also used to produce compost for organic crops. Available at: <https://www.caviro.com> Accessed: 12/10/2022.

30 Thompson (2017) also notes that in many non-Western societies, the value attributed to items is much greater after they have been discarded.

31 Available at: https://www.planalto.gov.br/ccivil_03/_ato2007-2010/2010/lei/l12305.htm Accessed: Nov. 22, 2022.

Joaquim, revealed that many wine production enterprises still use burning to dispose of vine pruning waste. This causes the emission of greenhouse gases and thus generates socio-environmental impacts. Another problem observed and reported in the interviews carried out in this same region was the lack of separate collection of recyclable materials in São Joaquim, making it difficult to correctly dispose of various types of solid waste resulting from wine production, such as wine bottles.

Wine production depends on several factors. A bottle of wine is the result of human labor, the progressive use of technologies and, above all, certain environmental conditions involving soil, climate, water and a good interaction between these elements and ecological processes. Guiding activities in the wine-growing field towards a more sustainable and circular approach involves not only addressing current needs, but also guaranteeing the very continuity of this activity.

Final considerations

Wine growing has been expanding around the world. Technological advances have led to changes in production, consumption and the way it is stored, transported and marketed³². Investments in technology have made it possible to grow vineyards in unprecedented areas such as deserts in Israel and China, and arid regions of Brazil such as the Lower-Middle São Francisco valley, in the *sertão*, and the Cerrado, reshaping the wine-growing landscape in the country.

Although there are still small and medium-sized initiatives with a more artisanal structure, wine has also become a product of big business, produced on a large scale, and distributed globally. As the growing industrialization of wine production has changed wine consumption, leading to breaking down of cultural boundaries, it has also raised a series of questions, specifically regarding impacts on the environment and human health. Under the current agricultural model, which is guided by intensive production methods that are socio-environmentally predatory, wine production has raised concerns and revealed the need for alternative methods, especially those that can achieve greater circularity in this field³³.

Loss of biodiversity, air and water pollution, progressive soil degradation, intense generation of waste, as well as impacts on human health, whether of rural workers or consumers, and intensification of climate change are some of the problems associated with contemporary agriculture. Wine-growing practices date back to the distant past, yet as they have been perpetuated, intensified, and industrialized, they have contributed to the problems mentioned. Thus, the need to reconfigure this field has become increasingly urgent. Therefore, thinking about wine involves much more than its organoleptic aspects, it requires recognizing that as technologies have modified the various production stages, this age-old beverage is still dependent on both human action and the environmental conditions that make its materiality possible.

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32 There have been global changes in wine consumption in recent years, according to the International Organization of Vine and Wine (OIV). Between 2000 and 2017 wine began to be consumed outside the country in which it is produced. The organization's world wine report for 2019 points to a downward trend (or stagnation) in the main consumer countries, while consumption rose in new regions, especially in Asian countries. Available at: <http://www.oiv.int/en/oiv-life/oiv-2018-report-on-the-world-vitivinicultural-situation> Accessed January 2020.

33 In 2018, the International Organization of Vine and Wine (OIV), responsible for promoting viticulture on a global scale, included in its recommendations to its various national member bodies, including Brazil, the importance of observing more sustainable practices guided by: a global strategy on the scale of grape production and processing systems that simultaneously incorporate the economic sustainability of structures and territories to produce quality products, considering precise requirements in sustainable wine growing, environmental risks, product safety and consumer health, and valuing heritage, historical, cultural, ecological and landscape aspects.

References

- ALTIERI, Miguel A. 1999. "The ecological role of biodiversity in agroecosystems Agriculture". *Ecosystems and Environment*, 74: 19-31.
- BLACK, Rachel E.; ULIN, Robert C. 2013. "Introduction". In: Rachel E. Black; Robert C. Ulin (eds.), *Wine and culture: vineyard to glass*. London/New York: Bloomsbury Publishing. pp. 1-10.
- BLACK, Rachel E. 2013. "Vino Naturale: Tensions between Nature and Technology in the Glass". In: Rachel E. Black; Robert C. Ulin (eds.), *Wine and culture: vineyard to glass*. London/New York: Bloomsbury Publishing. pp. 279-294.
- BOMBARDI, Larissa Mies. 2017. *Geografia do Uso de Agrotóxicos no Brasil e Conexões com a União Europeia*. São Paulo: FFLCH – USP.
- CAMPBELL, Gwyn; GUIBERT, Nathalie. 2007. "Introduction: The History and Culture of Wine". In: Gwyn Campbell; Nathalie Guibert (ed.), *Wine, Society, and Globalization: Multidisciplinary Perspectives on the Wine Industry*. New York: Palgrave Macmillan. pp. 1-16.
- CARSON, Rachel. 2010. *Primavera Silenciosa*. São Paulo: Gaia.
- CHRIST, Katherine L.; BURRITT, Roger L. 2013. "Critical environmental concerns in wine production: an integrative review". *Journal of Cleaner Production*, 53: 232-242.
- DAYNES, Sarah. 2013. "The social life of terroir among Bordeaux Winemakers". In: Rachel E. Black; Robert C. Ulin (eds.), *Wine and culture: vineyard to glass*. London/New York: Bloomsbury Publishing. pp. 15-32.
- DOUGLAS, Mary. 1991. *Pureza e Perigo. Ensaio sobre as noções de Poluição e Tabu*. Lisboa: Edições 70.
- DUTRA, Adriana Soares. 2021. "Apontamentos sobre o passado, o presente e o futuro da gestão de resíduos no Brasil". In: Valéria Pereira Bastos; Ubirajara Aluizio de Oliveira Mattos (ed.), *A política nacional de resíduos sólidos e seus 10 anos de execução*. 1ª ed. Rio de Janeiro: Letra Capital (e-book).
- GOMIERO, Tiziano; PIMENTEL, David; PAOLETTI, Maurizio G. 2011. "Is There a Need for a More Sustainable Agriculture?" *Critical Reviews in Plant Sciences*, 30:(1-2): 6-23.
- GRIVETTI, Louis E. 1995. "Wine: The Food with Two Faces". In: McGovern, Patrick E.; Fleming, Stuart J.; Katz Solomon H. (ed.), *The Origins and Ancient History of Wine*. Luxembourg: Gordon and Breach Publishers. pp. 9-22.
- HERBERGER, M. 2012. "Australia's millennium drought: impacts and responses". In: P. H. Gleick (ed.), *The World's Water Volume 7: The Biennial Report on Fresh- water Resources*. Washington DC: Island Press. pp. 97-125.
- JOHNSON, Hugh. 1999. *A história do vinho*. São Paulo: Cia. das Letras.
- MATTOS, Ubirajara Aluizio de Oliveira. 2021. "Balanço dos avanços e retrocessos da Política Nacional de Resíduos Sólidos". In: Valéria Pereira Bastos; Ubirajara Aluizio de Oliveira Mattos (ed.), *A política nacional de resíduos sólidos e seus 10 anos de execução*. 1ª ed. Rio de Janeiro: Letra Capital (e-book).
- MCDONOUGH, William. 2002. *Cradle to Cradle: Remaking the Way We Make Things*. New York: North Point Press.
- MCGOVERN, Patrick; FLEMING, Stuart. 1994. *The origins and ancient history of wine*. Luxembourg: Gordon & Breach Publishers.
- MCNEIL, J.R.; ENGELKE, Peter. 2016. *The great acceleration: an environmental history of the anthropocene since 1945*. Cambridge/Massachusetts/London/England: The Belknap Press of Harvard University Press.
- PATTERSON Tim; BUECHSENSTEIN, John. 2018. *Wine and Place: A terroir reader*. Oakland, California: University of California Press.
- PHILLIPS, Rod. 2005. *Uma breve história do vinho*. 3ª ed. Rio de Janeiro: Record.
- PORTO-GONÇALVES, Carlos Walter. 2015. *A globalização da natureza e a natureza da globalização*. 6ª ed. Rio de Janeiro: Civilização Brasileira.

- RAWORTH, Kate. 2017. *Doughnut Economics: seven ways to think like a 21st-century economist*. London: Penguin Random House.
- ROSNER, Franz Gerhard et al. 2015. *Assessment of sustainability in Austrian wine production BIO Web of Conferences*, 5. Disponível em: DOI: <https://doi.org/10.1051/bioconf/20150501022> Acesso em: outubro/2020.
- SACHS, Ignacy. 1990 “Desarrollo sustentable, bio-industrialización descentralizada y nuevas configuraciones rural-urbanas. Los casos de India y Brasil”. *Pensamiento Iberoamericano*, 46: 235-256.
- SACHS, Ignacy. 2002. *Caminhos para o desenvolvimento sustentável*. 2ª. ed. Rio de Janeiro: Garamond.
- TATTERSALL, Ian; DESALLE, Rob. 2015. *A Natural History of Wine*. New Haven & London: Yale University Press.
- THOMPSON, Michael. 2017. *Rubbish Theory: The Creation and Destruction of Value*. 2ª ed. London, UK: Pluto Press.
- SHIVA, Vandana. 2016. *The violence of the green revolution – third world agriculture, ecology and politics*. Kentucky: University Press of Kentucky.
- SZOLNOKI, G. 2013. “A cross-cultural comparison of sustainability in the wine industry”. *Journal of Cleaner Production*, 53(15): 243-251.
- TONON, Renata Valeriano et al. 2018. *Tecnologias para o Aproveitamento Integral dos Resíduos da Indústria Vitivinícola*. Rio de Janeiro: Embrapa Agroindústria de Alimentos.
- ULIN, Robert C. 2013. “Terroir e Locality: An Anthorpological Perspective”. In: Rachel E. Black; Robert C. Ulin (eds.), *Wine and culture: vineyard to glass*. London/New York: Bloomsbury Publishing. pp. 67-84.
- UNWIN, Tim. 1996. *Wine and the Vine: An Historical Geography of Viticulture and the Wine Trade*. Routledge: London.
- WEETMAN, Catherine. 2021. *A Circular Economy Handbook: How to Build a More Resilient, Competitive and Sustainable Business*. 2ª ed. London/NewYork: Kohan Page.
- ZACHAROF, Myrto-Panagiota. 2017. “Grape Winery Waste as Feedstock for Bioconversions: Applying the Biorefinery Concept”. *Waste Biomass Valor*, 8: 1011–1025.

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